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(71)Applicant : RICOH CO LTD

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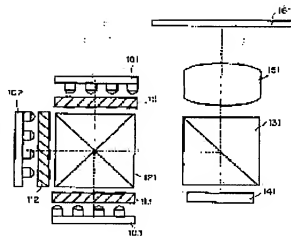
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(54) IMAGE PROJECTION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide new lighting technology which actualizes both high light use efficiency and a small-sized optical system, with respect to an image projection device using a liquid crystal panel which uses light emitting diodes as light sources and modulates polarized light.

SOLUTION: The LED light sources 101 to 103 composed of light emitting diodes corresponding to light sources of red, green, and blue and are so constituted as to put the three color lights by a dichroic prism 121 and lighten up a liquid crystal light valve 131. Polarized light converting elements 111 to 113 functions to polarize the lights emitted by the light emitting diodes so that the liquid crystal light valve is lit up. A polarizing beam splitter 131 functions as a polarizer which make uniform the polarized lights made incident on the liquid crystal light valve and also functions as an analyzer for projection lights. The light modulated by the liquid crystal light valve 141 is projected on a screen 161 by a projection lens 151.



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CLAIMS

[Claim(s)]

[Claim 1] The image projection device characterized by preparing the polarization sensing-element array which carries out polarization conversion of the outgoing radiation light from each aforementioned light emitting diode according to an individual in the image projection device equipped with the liquid crystal light valve which is illuminated and modulates the polarization condition of this illumination light that carried out incidence, and the projector lens for projecting the outgoing radiation light from this liquid crystal light valve by the light source light from the light source which consists of two or more light emitting diodes, and this light source.

[Claim 2] It is the image projection device according to claim 1 characterized by making said polarization sensing-element array correspond to the array of this light emitting diode near the convergent point which this outgoing radiation light converges while preparing a lens into the outgoing radiation optical path from this each light emitting diode so that it may be completed by the outgoing radiation light from each aforementioned light emitting diode, and preparing.

[Claim 3] Said polarization sensing-element array is an image projection device according to claim 1 characterized by being arranged in the optical path with which it is near said light emitting diode and, which the outgoing radiation beam from each ***** does not intersect substantially.

[Claim 4] The image projection device of claim 2 characterized by being arranged in the optical path with which the lens as which the outgoing radiation light from light emitting diode is completed, and a polarization sensing-element array are near the light emitting diode and, which the outgoing radiation beam from each light emitting diode does not intersect substantially.

[Claim 5] Claim 1 characterized by having the lens array which carries out abbreviation parallel Guanghua of the beam of light into the emission optical path near [said] the polarization sensing element thru/or an image projection device given in any 1 of 4.

[Claim 6] Claim 1 which two dimensions come to arrange said two or more light emitting diodes, and the pitch between two or more outgoing radiation light beams from said polarization sensing-element array is in abbreviation etc. by carrying out in the direction of length and width, and is characterized by things thru/or an image projection device given in any 1 of 5.

[Claim 7] The image projection device according to claim 6 characterized by doubling the array direction of said polarization sensing element in the long direction of the array pitch of said light emitting diode while setting the aspect ratio of the array pitch of said light emitting diode to about 2.

[Claim 8] The image projection device according to claim 6 characterized by the thing on which abbreviation etc. spreads the aspect ratio of the array pitch of said light emitting diode, and which has been arranged so that the include angle of the direction of the array of the array direction of said polarization sensing element of said light emitting diode and 45 degrees of abbreviation may be accomplished while carrying out.

[Claim 9] Said polarization sensing-element array is claim 1 characterized by arranging a polarization beam splitter, a flux of light reflective component, and the unit element child having 1/2 wavelength plate thru/or an image projection device given in any 1 of 8.

[Claim 10] Claim 1 characterized by making into one light source array the light source which comes to arrange the light emitting diode which has the luminescent color of the same color, compounding the light from this light source array of the different luminescent color, and illuminating said liquid crystal light valve thru/or an image projection device given in any 1 of 9.

[Claim 11] The image projection device according to claim 10 characterized by performing a multicolor display by synchronizing luminescence of said light source array of two or more colors with this switch with a

sequential change, and operating said liquid crystal light valve.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] This invention relates to the image display device of a projection mold, and the image projection device which made light emitting diode the light source in detail.

[0002]

[Description of the Prior Art] It was common to have used discharge lamps, such as a high-pressure mercury lamp and a metal halide lamp, as the light source in the conventional projection mold display. The light from the light source is led to light valves, such as liquid crystal, and the light modulated with the light valve is led to a projector lens as incident light, and it is projected on a screen. However, such a discharge lamp had the problem that it was large, therefore the size of the whole optical system became large.

[0003] Furthermore, the approach the above lamps perform a spectrum in three colors in order to perform color display, since it is the white light, they prepared a light valve about each colored light, compounded again the light modulated with the light valve, and led it to a projector lens was taken. Therefore, there was a problem that optical system benefited a spectrum and composition large further.

[0004] Moreover, as an option, a spectrum is not performed but how to become irregular with one liquid crystal light valve which prepared the color filter is also learned. However, since the number of pixels of a light valve was restricted, by this approach, the number of pixels was set to one third compared with the approach of using three light valves, and there was a problem that a high definition display could not be performed.

[0005] On the other hand, the projection mold display using light emitting diode (LED) as the light source is proposed in recent years. Since light emitting diode is small in itself, it may be able to realize small equipment. Since light emitting diode can change lighting and an astigmatism LGT in an instant in addition to it, there is also an advantage that the so-called display of a FIRUDO seeking en SHARU method is possible. This carries out sequential lighting of the LED of RGB3 color using the light valve of one sheet, is synchronized with it, and switches a light valve. Color display can be made to perform according to this approach, without dropping resolution on the light valve of one sheet.

[0006] In the image projection device which used the liquid crystal panel as the modulation element, a liquid crystal panel performs image formation by modulating the polarization condition of incident light. Therefore, between a liquid crystal panel and the light source, a polarizing plate and a polarizer like a polarization beam splitter are used. Since the illumination light generally did not polarize, with having illuminated as it is, the quantity of light more than one half will be lost with a polarizer. Therefore, with equipment in recent years, the polarization sensing element was prepared between the light source and a light valve, and changing so that it may become only polarization of a request of the illumination light has accomplished.

[0007] Drawing 9 is the block diagram having shown the example of typical structure of the above conventional polarization sensing elements. While was separated by the polarization beam splitter 241 and the polarization beam splitter, and the polarization sensing element was prepared into the optical-path modification means 242, such as a mirror for using polarization as the optical axis of polarization of another side at parallel, and the optical path of one polarization, and is equipped with the phase contrast plate 243 for changing 90 degrees of plane of polarization to incident light. With the configuration of drawing 9, as shown in drawing, one width of face of a beam of light will become twice. This will lengthen the optical path length for reducing the flux of light to the size of a light valve, and will enlarge magnitude of the whole optical system.

[0008] Drawing 10 is the block diagram showing the example of a configuration of another conventional polarization sensing element. The polarization sensing-element array 240 is about the same poor structure as

plurality about this considering the polarization sensing element of drawing 9 as one unit. This polarization sensing-element array is used combining the fly eye integrator optical system 292,293 as shown in drawing 10, and it makes polarization conversion perform, while it makes incorporation effectiveness of a beam of light high by preparing in the part to which the about 293 second fly eye lens beam was extracted, without extending a beam diameter. For this reason, a small and efficient image projection device is realizable.

[0009]

[Problem(s) to be Solved by the Invention] On the other hand, alone, since brightness is insufficient as the light source of a projection mold display, light emitting diode needs to make plurality arrange and it is necessary to use it. In the configuration of the multi-light source 201 of such a light emitting diode, when the integrator optical system 292,293 and the polarization sensing element 240 are combined like drawing 11, it becomes impossible to condense the light from the different light source correctly to the polarization beam splitter of a polarization sensing element, and it will produce loss of the quantity of light by it with an eclipse etc. Thus, in the system using a discharge lamp and a polarization sensing element, when the light source was made into the light emitting diode light source, it was difficult to reconcile high efficiency for light utilization and small optical system.

[0010] This invention is made in view of the actual condition like ****, makes light emitting diode the light source, and aims at offering the new lighting technology which reconciled high efficiency for light utilization and small optical system in the image projection device using the liquid crystal panel which modulates polarization.

[0011]

[Means for Solving the Problem] Invention of claim 1 is characterized by to prepare the polarization sensing-element array which carries out polarization conversion of the outgoing radiation light from each aforementioned light emitting diode according to an individual in the image projection device equipped with the liquid crystal light valve which is illuminated and modulates the polarization condition of this illumination light that carried out incidence, and the projector lens for projecting the outgoing radiation light from this liquid crystal light valve by the light source light from the light source which consists of two or more light emitting diodes, and this light source.

[0012] While invention of claim 2 prepares a lens in invention of claim 1 into the outgoing radiation optical path from this each light emitting diode so that it may be completed by the outgoing radiation light from each aforementioned light emitting diode, said polarization sensing-element array is characterized by making it correspond to the array of this light emitting diode near the convergent point which this outgoing radiation light converges, and preparing.

[0013] Invention of claim 3 is characterized by arranging said polarization sensing-element array in the optical path with which it is near said light emitting diode and which the outgoing radiation beam from each ***** does not intersect substantially in invention of claim 1.

[0014] Invention of claim 4 is characterized by being arranged in the optical path with which the lens as which the outgoing radiation light from light emitting diode is completed, and a polarization sensing-element array are near the light emitting diode and which the outgoing radiation beam from each light emitting diode does not intersect substantially in invention of claim 2.

[0015] Invention of claim 5 is characterized by having the lens array which carries out abbreviation parallel Guanghua of the beam of light into the emission optical path near [said] the polarization sensing element in claim 1 thru/or invention of any one of 4.

[0016] In claim 1 thru/or invention of any one of 5, two dimensions come to arrange said two or more light emitting diodes, in the direction of length and width, the pitch between two or more outgoing radiation light beams from said polarization sensing-element array carries out abbreviation etc., is in invention of claim 6, and it is characterized by things.

[0017] In invention of claim 6, invention of claim 7 is characterized by doubling the array direction of said polarization sensing element in the long direction of the array pitch of said light emitting diode while it sets the aspect ratio of the array pitch of said light emitting diode to about 2.

[0018] In invention of claim 6, invention of claim 8 is characterized by the thing for which abbreviation etc. spreads the aspect ratio of the array pitch of said light emitting diode and which has been arranged so that the include angle of the direction of the array of the array direction of said polarization sensing element of said light emitting diode and 45 degrees of abbreviation may be accomplished while carrying out.

[0019] Invention of claim 9 is characterized by said polarization sensing-element array arranging a polarization beam splitter, a flux of light reflective component, and the unit element child having $1/2$ wavelength plate in

claim 1 thru/or invention of any one of 8.

[0020] Invention of claim 10 is characterized by making into one light source array the light source which comes to arrange the light emitting diode which has the luminescent color of the same color, compounding the light from this light source array of the different luminescent color, and illuminating said liquid crystal light valve in claim 1 thru/or invention of any one of 9.

[0021] Invention of claim 11 is characterized by performing a multicolor display in invention of claim 10 by synchronizing luminescence of said light source array of two or more colors with this switch with a sequential change, and operating said liquid crystal light valve.

[0022]

[Embodiment of the Invention] (Example 1) Drawing 1 is the mimetic diagram showing the whole one example configuration of the image projection device by this invention, the light source (LED light source) which 101-103 become from two or more light emitting diodes in drawing 1, and 111-113 -- in a polarization beam splitter and 141, the liquid crystal light valve of a reflective mold and 151 express a projector lens, and, as for a polarization sensing element and 121, 161 expresses [a dichroic prism and 131] a screen. Light emitting diodes 101-103 correspond to the light source of blue, green, and red respectively, compound three colored light with a dichroic prism 121, and they consist of this examples so that the liquid crystal light valve 141 may be illuminated. The polarization sensing elements 111-113 function as arranging the light which came out of the light emitting diode with the polarization condition which illuminates a liquid crystal light valve.

[0023] A polarization beam splitter 131 functions also as an analyzer to outgoing radiation light while functioning as a polarizer which arranges the incidence polarization to the liquid crystal light valve 141. This configuration is an example, for example, by making the light emitting diode group of the light source into one unit, a dichroic prism can be omitted or it can also use a polarizing plate 142,143 instead of a polarization beam splitter like drawing 4, using the thing of a transparency mold as a liquid crystal light valve. Moreover, between the polarization sensing elements 111-113 and the liquid crystal light valve 141, the integrator optical system for equalizing the field lens and illumination light for accepting the need, expanding the illumination light and reducing etc. can also be inserted.

[0024] Drawing 2 is the mimetic diagram showing the first example of a configuration of the lighting section of the image projection device by this invention. The lens 20 for controlling the breadth of outgoing radiation light is formed in the front face of the arranged light emitting diodes 11-15. 40 is a polarization sensing element and consists of the optical-path modification components 42 and 1/2 wavelength plates 43 which consist of a polarization beam splitter 41, a mirror, a polarization beam splitter, etc. A polarization sensing element is prepared corresponding to each light emitting diode, and it is constituted so that the beam from each light emitting diode may be changed according to an individual.

[0025] As mentioned above, before the flux of light from each light emitting diodes 11-15 crosses, by forming the polarization sensing element 40, the quantity of light loss by the boundary section of the polarization sensing element 40 can be prevented, and an efficient illumination system can be built. It is difficult to make completely parallel outgoing radiation light from light emitting diode generally, and in order to form the polarization sensing element 40 before the flux of light from light emitting diodes 11-15 crosses like this invention, it is desirable to form the polarization sensing element 40 immediately after light emitting diode. In addition, as for light emitting diodes 11-15, in drawing 2, having arranged also to the space perpendicular direction is desirable.

[0026] (Example 2) Drawing 3 is the mimetic diagram showing the second example of a configuration of the lighting section of the image projection device by this invention. The lenses 20 and 30 for controlling the breadth of outgoing radiation light are formed in the front face of the arranged light emitting diodes 11-15. 40 is a polarization sensing element. In this example, the outgoing radiation light from light emitting diodes 11-15 is constituted so that it may converge with lenses 20 and 30, it is made to correspond to the array of light emitting diodes 11-15 near [convergent point] this, and the polarization sensing-element array 40 is formed.

[0027] By adopting the above configurations, like an example 1, the quantity of light loss by the boundary section of the polarization sensing element 40 can be prevented, and an efficient illumination system can be built. Furthermore, by having formed the polarization sensing element 40 near the convergence section, the pitch of the polarization sensing element 40 can be made into abbreviation 1/2, beam divergence can be stopped, and it becomes possible to constitute the dimension of the whole illumination system small by it.

[0028] In the configuration of drawing 3, although convergence optical system was constituted from a set of two lenses 20 and 30, it is also possible to constitute convergence optical system only, for example from a lens

20. It is difficult to make completely parallel outgoing radiation light from light emitting diode generally, and in order to complete the flux of light and to lead to the polarization sensing element 40 before the flux of light from light emitting diodes 11-15 crosses like this invention, it is desirable to form focusing lenses 20 and 30 and the polarization sensing element 40 immediately after light emitting diode.

[0029] moreover, the emission flux of light to which 50 is a micro-lens array and this carried out outgoing radiation of the polarization sensing element 40 in drawing 3 — abbreviation — it has the function changed into the parallel flux of light. Moreover, the micro-lens array 50 may be before the polarization sensing element 40. It is more desirable to form this lens array 50, to stop the breadth of the flux of light, and to stop the size of optical system. Moreover, as for light emitting diodes 11-15, having arranged also to the space perpendicular direction is desirable like an example 1.

[0030] (Example 3) Drawing 5 is the mimetic diagram showing the example of a configuration in which the homogeneity of an illuminance has been improved in the image projection device in connection with this invention. Drawing 5 illustrates the polarization sensing-element array when seeing a polarization sensing element from an outgoing radiation side, and the relation of the array of light emitting diode. In drawing 5, 40 is a polarization sensing-element array and light emitting diode 10a is arranged in the rear face. The pitch of the array of a luminescence diode array is in every direction, it differs, and the lengthwise direction is arranged in the twice as many pitch as this in this example. The array direction (direction where a polarization sensing element adjoins) of the polarization sensing-element array 40 has agreed in the direction where the pitch of a light emitting diode is long.

[0031] In this example, outgoing radiation of the light which penetrated the polarization beam splitter among the outgoing radiation light from optical diode will be carried out from the location of 10a, and outgoing radiation of the reflected light of a polarization beam splitter will be carried out from the location of 10b. That is, an outgoing radiation location will be distributed over homogeneity and can raise the homogeneity of the field illuminance of the outgoing radiation light from a polarization sensing element, i.e., the illuminance homogeneity of a projection image.

[0032] (Example 4) Drawing 6 is the mimetic diagram showing another example of a configuration in which the homogeneity of an illuminance has been improved in the image projection device in connection with this invention. Drawing 6 illustrates the polarization sensing-element array when seeing from the outgoing radiation side of a polarization sensing element, and the relation of the array of light emitting diode. In drawing 6, 40 is a polarization sensing-element array and light emitting diode 10a is arranged in the rear face. The aspect ratio of the array pitch of a light emitting diode spreads abbreviation etc., and is set up, and the array direction of the polarization sensing element 40 is arranged so that the include angle of the direction of the array of light emitting diode 10a and 45 degrees of abbreviation may be accomplished.

[0033] By the above configurations, outgoing radiation of the reflected light of the polarization beam splitter in a polarization sensing element will be carried out from the core of the square formed of the core of four adjoining light emitting diodes, and when an outgoing radiation location is distributed over homogeneity, it can raise the homogeneity of the field illuminance of the outgoing radiation light from a polarization sensing element, i.e., the illuminance homogeneity of a projection image.

[0034] Drawing 7 is drawing for explaining arrangement of the desirable phase contrast plate in a configuration as shown in above-mentioned drawing 6. The strip-of-paper-like phase contrast plate 43 is arranged so that the direction of the array of a polarization sensing element and the include angle of 45 degrees may be accomplished. The phase contrast plate 43 is formed in the optical path of either the transmitted light of the polarization beam splitter of a polarization sensing element, or the reflected light. By such configuration, also when the array direction of light emitting diode and a polarization sensing element inclines, a phase contrast plate can be easily arranged in the corresponding location.

[0035] (Example 5) Drawing 8 is drawing for explaining the desirable example to which high definition color display is made to carry out in the configuration of drawing 1. Between the blue LED light source 101 and the polarization sensing element 111, the micro-lens array 171 which consists of a convex lens is formed, and the second micro-lens array 181 is formed between the polarization sensing element 111 and the dichroic prism 121. The micro-lens array 172,173, first, and second micro-lens arrays 182,183 are similarly formed in the green LED light source 102 and the red LED light source 103 respectively, and optical system as respectively shown in drawing 3 is constituted.

[0036] With a dichroic prism 121, color composition is carried out and incidence of the abbreviation parallel light which came out of the micro-lens arrays 181-183 is carried out to a polarization beam splitter 131. The lens

191 prepared between the polarization beam splitter 131 and the dichroic prism 121 is a field lens for reducing the size of the light source to the size of the liquid crystal light valve 141, and a micro lens 192,193 is the integrator optical system for equalizing the illumination light on a liquid crystal light valve.

[0037] Moreover, in drawing 8, 141 is the liquid crystal light valve of a reflective mold, and it consists of this examples so that it may be illuminated by S polarization from a polarization beam splitter 131. Therefore, it is constituted so that incidence also of the polarization sensing elements 111-113 may be carried out by S polarization to a polarization beam splitter 131. And it is reflected with the liquid crystal light valve 141, and the light modulated so that plane of polarization might rotate penetrates a polarization beam splitter 131, and it is projected on it by the screen 161 through a projector lens 151.

[0038] In the configuration of this example, the number of the liquid crystal light valves 141 is one so that it may illustrate, and in order to make color display perform in such a configuration, they carry out sequential lighting of the light emitting diode, are synchronized with it, and modulate a light valve 141. That is, when blue is on, a blue image is displayed, and red and the modulation according [shift time amount even if it attaches green, and] to lighting of a light emitting diode and a light valve are performed similarly.

[0039] Compared with the conventional optical system which carries out the spectrum of the configuration of this example using a discharge lamp, using a liquid crystal light valve only in one sheet, it has the merit that the magnitude of the whole optical system can be designed small since the illumination-light study system is small. The illumination system using the optical system of the polarization conversion by this invention has still higher effectiveness, therefore since the number of the light emitting diodes to be used can be reduced, there is an advantage that a still smaller illumination system can be constituted. Since a high-speed switching characteristic is required of such a field seeking on SHARU method, the thing using the ferroelectric liquid crystal as a liquid crystal light valve is used especially preferably.

[0040] In the above explanation, light emitting diode and a polarization sensing element are combined, and the configuration of the illumination system of this invention which performs polarization conversion before the outgoing radiation light from each luminescence diode array crosses is not limited to the configuration of drawing 1 or drawing 8. For example, the light emitting diode of two or more colors can be arranged to one lighting unit, and it can also use for this one lighting unit combining said polarization conversion optical system. Moreover, two or more units can also be put in order and used for light emitting diode, and what was beforehand formed as an array can also be used for it.

[0041] Moreover, as a liquid crystal light valve, the thing of a reflective mold can also use the thing of a transparency mold. Moreover, although the example explained the case where a dichroic prism was used, about color composition, the configuration of the combination of a cross dichroic mirror or a dichroic mirror etc. is also employable.

[0042]

[Effect of the Invention] In the image projection device equipped with the liquid crystal light valve which this invention is illuminated by the light source which consists of two or more light emitting diodes, and light source light, and modulates the polarization condition of incident light, and the projector lens It is characterized by preparing the polarization sensing-element array which carries out polarization conversion of the outgoing radiation light from each light emitting diode according to an individual, it becomes possible to lead the outgoing radiation light from light emitting diode to a polarization sensing element without a loss [****] by such configuration, and an efficient image projection device can be realized.

[0043] While preparing a lens into the outgoing radiation optical path from each light emitting diode so that it may furthermore be completed by the outgoing radiation light from each light emitting diode, since outgoing radiation light can be more efficiently led to a polarization sensing element, in the image projection device by this invention characterized by having made it correspond to the array of light emitting diode near [convergent point] this, and preparing a polarization sensing-element array, a still more efficient image projection device is realizable.

[0044] Moreover, the lens and polarization sensing-element array as which the outgoing radiation light from light emitting diode is completed are near the light emitting diode. And it is arranged in the optical path which the outgoing radiation beam from each light emitting diode does not intersect substantially. In the image projection device arranged in the optical path with which a polarization sensing-element array is near the light emitting diode and, which the outgoing radiation beam from each light emitting diode does not intersect substantially Since it can lead to a polarization sensing element in the condition that the outgoing radiation light from light emitting diode is not intermingled, and an outgoing beam can be led without an eclipse to a polarization sensing

element, a still more efficient image projection device is realizable.

[0045] In the image projection device characterized by furthermore having the lens array which carries out abbreviation parallel Guanhua of the beam of light into the emission optical path near the polarization sensing element, since the breadth of the outgoing radiation light from a polarization sensing element can be stopped, it becomes possible to design optical system small, and the whole equipment can be constituted small.

[0046] In the image projection device which two dimensions furthermore come to arrange a light emitting diode, and the pitch between the outgoing radiation light beams from a polarization sensing-element array is in abbreviation etc. by carrying out in the direction of length and width, and is characterized by things, the intensity distribution of the illumination light can be made more into homogeneity, and the high image projection device of display homogeneity can be realized more.

[0047] A characterizing [it]-by doubling array direction of polarization sensing element in direction where pitch of light emitting diode is long image projection device while setting the aspect ratio of the array pitch of a light emitting diode to about 2 furthermore offers the desirable new implementation means of the configuration that the pitch between the outgoing radiation light beams from a polarization sensing-element array spreads abbreviation etc. in the direction of length and width so that it may become.

[0048] further -- the aspect ratio of the array pitch of a light emitting diode -- abbreviation -- the image projection device characterized by having arranged so that the include angle of the direction of the array of the array direction of a polarization sensing element of a light emitting diode and 45 degrees of abbreviation may be accomplished while making it equal -- the pitch between the outgoing radiation light beams from a polarization sensing-element array -- the direction of length and width -- abbreviation -- the desirable new implementation means of a configuration so that it may become equal is offered.

[0049] The image projection device with which a polarization sensing-element array furthermore arranges a polarization beam splitter, a flux of light reflective component, and the unit element child having $1/2$ wavelength plate offers the desirable concrete example of a configuration of a polarization sensing element.

[0050] While making into one light source array the light source which comes to arrange the light emitting diode which furthermore has the luminescent color of the same color, compounding the light from the light source array of the different luminescent color and illuminating a liquid crystal light valve Since the image projection device characterized by performing a multicolor display by synchronizing luminescence of the light source array of two or more colors with it with a sequential change, and operating a liquid crystal light valve can constitute optical system very small, it can offer a small image projection device.

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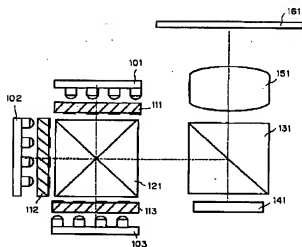
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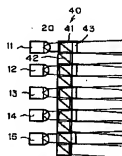
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DRAWINGS

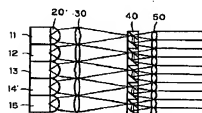
[Drawing 1]



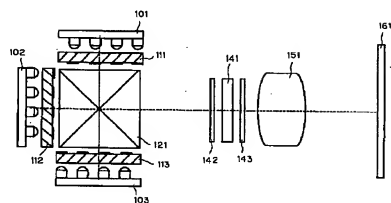
[Drawing 2]



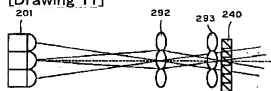
[Drawing 3]



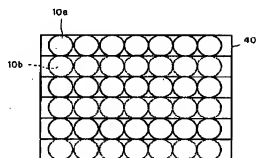
[Drawing 4]



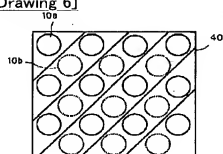
[Drawing 11]



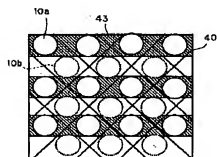
[Drawing 5]



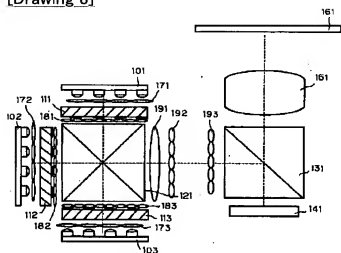
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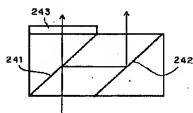
[Drawing 7]



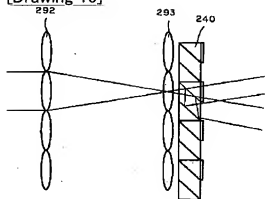
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]